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SUMMARIES OF PRE-CAMBRIAN LITERATURE OF NORTH AMERICA FOR 1909, 1910, 1911, AND PART OF 1912

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V. QUEBEC

Barlow[1] states that the Chibougaman region of Quebec is underlaid by Keewatin, Laurentian, and Huronian formations, and a gabbro anorthosite.

Barlow[2] states that the Chibougaman region, lying between latitudes 49° 30′ and 50° 11′ 06″ north and longitude 70° 03′ 40″ to 74° 35′ 50″, about 300 miles north of Montreal, has the following pre-Cambrian succession region, beginning with the oldest: (1) Keewatin, serpentine and pyroxenite; deformed quartz porphyry and porphyrites, basalts, diabases and gabbros; (2) anorthosite intrusive into Keewatin; (3) Laurentian granites, granite and diorite gneiss intrusive into (1) and (2); (4) unconformity; (5) Lower Huronian—slates, sandstones, arkose and conglomerate.

Bancroft[3] classifies the pre-Cambrian rocks of the Harricanaw and Nottaway rivers of northwestern Quebec as Keewatin metamorphosed extrusive and intrusive basic and acid igneous rocks with bands of highly altered sedimentary rocks; Laurentian granites and granite gneisses intrusive into the Keewatin; Lower Huronian (?) conglomerates, graywacke, slate, and arkose, injected by granite; post-Middle Huronian (Keweenawan ?) dikes of quartz and olivine diabase.

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[1] "Geology of the Chibougaman Region, Quebec," *Canada Geol. Soc. Am. Bull.*, XXII, No. 4 (1911), 738 pp.

[2] "Geology and Mineral Resources of the Chibougaman Region," Report by the Chibougaman Mining Concession, *Province of Quebec, Canada*, 1911, 215 pp., 68 pls., 19 figs., 2 maps.

[3] J. A. Bancroft, "Geology and Natural Resources of the Basins of Harricanaw and Nottaway Rivers, Northwestern Quebec," *Province of Quebec*, 1912, 16 pp., 1 map.

Cirkel[1] states the Amherst graphite deposits occur as lenticular masses and pockets, disseminations, and veins in eruptive rock intrusive into the Grenville limestones. Graphite occurs within feldspar, quartz, and pyroxene. It is mostly associated with feldspar or pyroxene, less frequently with calcite and wollastonite. Garnet, zircon, scapolite, titanite, muscovite, pyrite, apatite, leucoxene, biotite and monazite are accessory minerals of the gangue.

Dulieux[2] reports that the rocks of the Lake Chibŏgomon region, north of Lake St. John, in Quebec, constitute an isolated belt of diabases and gabbros and rocks derived from them; viz., chloritic, epidotic, talc schists, and serpentine, surrounded by Laurentian granites and gneisses, the backbone of Labrador. They contain deposits of cupriferous and auriferous sulphides, magnetic iron, and asbestos.

Wilson[3] finds that the pre-Cambrian rocks in western Quebec between 75° 30′ and 79° 30′ west longitude and 48° and 49° north latitude include hornblende schists, chlorite schists, diabase, and porphyries, all probably of Keewatin age, and Laurentian granites and gneisses.

VI. THE CORDILLERAS

Ball[4] finds that the pre-Cambrian, magnetic, titaniferous iron ores of Iron Mountain in southeastern Wyoming form a series of dikes cutting anorthosite. Granitic masses dissect both. The ores and the anorthosite contain the same minerals with some minor exception, but in different proportions. The tonnage of ore is large, averaging high in iron, and probably low in phosphorus, but too high in titanium to be desirable under present conditions.

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[1] Fritz Cirkel, "The Amherst (Quebec) Graphite Deposits," *Quart. Bull. Can. Mining Inst.*, 1910, pp. 107–15.

[2] E. Dulieux, "The Chibŏgomon Region, Quebec," *Jour. Can. Min. Inst.*, XII (1909), 184–93.

[3] W. J. Wilson, "Geological Reconnaissance along the Line of the National Transcontinental Railway in Western Canada," *Canada Geol. Survey, Mem.* 4, (1910), pp. 56, 5 pls., 1 geol. map.

[4] Sidney H. Ball, "Titaniferous Iron Ore of Iron Mountain, Wyoming," *Bull. 315*, 1906, pp. 206–12.

Bancroft[1] states that the oldest rocks in Northern Yuma County, Arizona, are granites and diorites, probably of Archaean age. They are capped by a thick series of metamorphosed pre-Cambrian sediments, quartzites, limestones, dolomites, argillites, arenaceous shales, and quartz mica schists, interlayered and intruded by basic rocks altered to amphibolites.

Blackwelder[2] reports that the pre-Cambrian of three geologic sections in western Wyoming consists of gneiss, gray, and red granites penetrated by diabase and other dikes, hornblende gneiss, and granite with large dikes of diabase.

Blackwelder[3] states that the pre-Cambrian rocks of the Laramie and Sherman quadrangles of northeastern Wyoming include: (1) hornblende schists, associated with some schistose rhyolites and felsites, soft mica gneisses et cetera, and rocks resembling contorted quartzites, and limestones, all highly metamorphosed; these rocks are the oldest in the area; (2) mildly metamorphosed granite gneiss representing two periods of intrusion, both younger than (1); (3) basic intrusives, comprising syenites, gabbros, diorites, granodiorites, and gabbro gneiss, all younger than (2); (4) granite porphyry intrusive into (1) and (2); (5) anorthosite, intrusive into (1), (2), and the gabbro gneiss of (3); (6) granite intrusive into (1), (2), (3), (4), and (5); (7) small diabasic and dioritic dikes injected into (6) and probably younger than (7).

Blackwelder[4] finds an unconformity in Big Cottonwood Canyon along the upper course of the Ogden River in the Wasatch Mountains, between slightly fossiliferous early Cambrian quartzites and an older quartzite slate series, several thousand feet thick, which he assigns to the Algonkian in accordance with the prevailing methods of correlation.

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[1] Howland Bancroft, "Reconnaissance of the Ore Deposits in Northern Yuma County, Arizona," *Bull.* 451, *U.S. Geol. Survey*, 1911, pp. 130, maps and illustrations.

[2] Eliot Blackwelder, "A Reconnaissance of the Phosphate Deposits in Western Wyoming," *Bull. 470, U.S. Geol. Survey*, 1911, pp. 452–81.

[3] N. H. Darton, E. Blackwelder, C. E. Siebenthal, "The Laramie and Sherman Quadrangles, Wyoming," *U.S. Geol. Survey, Folio No. 173*, 17 pp., 8 pls., 3 figs.

[4] Eliot Blackwelder, "New Light on the Geology of the Wasatch Mountains, Utah," *Bull. Geol. Soc. Am.*, XXI (1910), 517–42, pls. 36–40.

The unconformity is shown by the variable thickness of the quartzite-slate series, slight discordance of bedding, and a basal conglomerate.

The Algonkian system consists of alternating quartzites, slates, and conglomerates, which are variable from place to place; and show cross-bedding, ripple marks, and mud cracks. The materials are not well assorted, and in the sandy beds, the prevailing colors are shades of red; green predominates in the shales. Fossils and limestone appear to be lacking. Blackwelder is inclined to view these sediments as subaerial, largely fluviatile deposits.

Cross and Hole[1] state that the pre-Cambrian in the Engineer Mountain quadrangle of Colorado include Archaean gneisses and schists derived from granites, diorites, and diabase. These are intruded by granitic and gabbroic masses. Several thousand feet of massive and some thin-bedded quartzites, white, brown, and black, and occasional bands of brown to black shale, all of Algonkian age, overlie the Archaean.

Diller[2] describes the occurrence of asbestos in the pre-Cambrian rocks near Casper, Wyo., and the Grand Canyon of Arizona. At Casper, Wyo., the asbestos occurs mostly at the igneous contact between serpentine and granite. In the Grand Canyon, asbestos occurs only where diabase sills have been intruded into Algonkian magnesian limestones.

Diller[3] states that the rocks of the asbestos area south and southeast of Casper, Wyo., are hornblende schist, diorite, granite, and serpentine of pre-Cambrian age.

In the Grand Canyon of Arizona, certain Algonkian limestone beds contain asbestos where they have been intruded by diabase sills.

Daly[4] finds that the great stratigraphic problem of the Shuswap Lakes region is the correlation of the non-fossiliferous, crystalline rocks which lie unconformably beneath the Carboniferous. Dawson found that an unconformity separated them into two divisions. The rocks beneath this unconformity he classed as pre-Cambrian and those above as Cambrian. Daly classifies all the rocks unconformably beneath the Carboniferous as pre-Cambrian, excepting a part of the quartzite rocks immediately underlying the Carboniferous which he believes may be Cambrian. The unconformity which Dawson believed separated the Cambrian from the pre-Cambrian Daly places within the pre-Cambrian, and calls the rocks below this unconformity pre-Beltian, and those above it Beltian, with the reservation previously stated that a part of the upper portion may be Cambrian.

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[1] W. Cross and A. H. Hole, "Engineer Mountain Folio," *U.S.G.S. Folio* 171, 1910, 14 pp., 5 pls., 1 fig.

[2] J. S. Diller, "The Types and Modes of Occurrence of Asbestos in the United States," *Jour. Can. Min. Inst.*, 1911, pp. 93–107.

[3] J. S. Diller, "The Types, Modes of Occurrence, and Important Deposits of Asbestos in the United States," *Bull. 470*, *U.S. Geological Survey*, 1911, pp. 505–23.

[4] R. A. Daly, "Reconnaissance of the Shuswap Lakes and Vicinity (South Central British Columbia), *Canada Department of Mines*, Ottawa, 1912.

The pre-Beltian consists of the dominantly Sedimentary Shuswap series, about 26,500 feet thick, which is intruded by batholiths, dikes, and sills of granite. It includes limestones, metargillites, mica-schists, paragneisses, green schists and greenstones, the latter probably of extrusive origin although no definite extrusive characteristics have been found. The Beltian is also dominantly sedimentary, consisting from the base up of about 200 feet of arkose sandstone overlain by about 18,000 feet of argillaceous rocks interbedded with limestones and quartzites, the whole constituting the Albert Canyon division. Above this is the Glacier quartzite division about 25,000 feet thick, the upper part of which, Daly believes, may be Cambrian, although no fossils have been found.

The strike of the pre-Cambrian rocks is nearly east and west or practically at right angles to the Cordilleran folding. Normal faulting in part contemporaneous with deposition is more evident than folding, and the bedding is either nearly horizontal or only slightly inclined. From the fact that both the Shuswap and the Beltian are dominantly schistose with their schistosity essentially parallel with the slightly deformed bedding. Daly infers that the schistosity has not resulted from tangential stress but from the weight of the sediments and the action of thermal solutions. While the pre-Cambrian rocks are only gently inclined, the Carboniferous and Triassic rocks of this region are highly folded.

The rocks of the Rocky Mountain geosynclinal are believed by Daly to be largely derived from the pre-Beltian. He finds that the microscopic characteristics of the feldspars in the sediments are identical with those of the granites, sills, and dikes which intrude the Shuswap series. The extraordinary fine grain of the quartzites he attributes to their derivations from metargillites, phyllites, and greenstone schists.

Daly does not care to have the term Algonkian applied to the pre-Cambrian of the Shuswap Lakes region, since it would include two series which are separated by a well marked unconformity.

Darton[1] records a few observations on the distribution of the Vishnu and Grand Canyon series in western New Mexico and northern Arizona.

Emmons[2] states that a complex of pre-Cambrian granites constitutes the basement upon which later sedimentary and igneous rocks of the Cananea district were superimposed.

Emmons[3] states that the oldest rocks of the Little Rocky Mountains between the Missouri and Milk rivers consist of pre-Cambrian quartzite by intrusive porphyry.

George and Crawford[4] find that the pre-Cambrian rocks of the Hahn's Peak region of Routt County, Colo., as a complex of schists, gneiss, gneissoid granite, and granite with isolated patches of quartzite.

Henderson[5] describes the pre-Cambrian rocks of the Front Range of Colorado, as consisting of Archaean granite and gneiss, and an Algonkian quartzite, outcropping from South Boulder Canyon southward a distance of about twelve miles. The latter is mostly white and in places coarsely conglomeratic, showing both bedding and cross-bedding.

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[1] N. H. Darton, "A Reconnaissance of Parts of Western New Mexico and Northern Arizona," *Bull 435, U.S. Geological Survey*, 1910, pp. 14–15.

[2] S. F. Emmons, "Cananea Mining District of Sonora," *Econ. Geol.*, V, No. 4 (1910), 312–.

[3] W. H. Emmons, "Gold Deposits of the Little Rocky Mountains, Montana," *Bull. 340, U.S. Geological Survey*, 1907, pp. 96–116.

[4] R. D. George and R. D. Crawford, "The Hahn's Peak Region, Routt County, Colorado," *Colo., Geol. Surv., 1st Rept.*, 1908, pp. 189–229, 1 pl., 1909.

[5] Junius Henderson, "The Foothills Formations of Northern Colorado," *Colo. Geol. Surv., 1st Rept.*, pp. 149–85, 1909.

Lindgren, Groton, and Gordon[1] find small areas of pre-Cambrian rocks, most of them in the northern part of New Mexico, exposed in eroded regions of doming and faulting, flanked by younger rocks. The largest, about 120 miles long, extends as a southward continuation of the Sangre de Cristo range of Colorado, to about 20 miles south of Santa Fe. It consists of a sedimentary series, chiefly quartzitic, which with certain greenstone tuffs, amphibolites, and rhyolites has been invaded by powerful intrusions of normal, usually reddish microcline granite, locally schistose. The granite in turn has been intruded by aplite, abundant pegmatite, and some masses or dikes of greenstone. The sediments are believed to correspond to those of Colorado similarly imbedded in red granite and to the quartzitic schists of the Pinal formation of Arizona, but the pre-Cambrian sediments of the Grand Canyon are believed to be younger than the red granite intrusions.

Unimportant ore deposits of gold and silver, some zinc and copper, but little lead are found in the granites, gneisses, and amphibolitic schists. Some rich gold placers have developed from them. The ores occur in quartz-filled fissures, usually of the "lenticular" type, shear zones filled with quartz stringers, and disseminations of sulphides in amphibolitic schists. The deposits frequently show evidence of deep-seated origin, such as the development of heavy minerals, and massive, glassy vein quartz. Many of them were folded and fractured. The ore deposition followed granitic and other intrusions, and the metals were probably delivered from the magmas.

Noble[2] describes the pre-Cambrian succession of the Shimuno area of the Grand Canyon. The following is a summarized section:

[1] W. Lindgren, L. C. Groton, and C. H. Gordon, "The Ore Deposits of New Mexico," *Prof. Paper 68, U.S. Geological Survey*, 1910, pp. —, several maps.

[2] L. F. Noble, "Contributions to the Geology of the Grand Canyon, Arizona. The Geology of the Shimuno Area, *Am. Jour. Science*, 4th Series, XXIX, 369–86.

UNCONFORMITY AT BASE OF CAMBRIAN

	Micaceous shaly sandstone uniform in composition but varying in color. Ripple marked and cross-bedded throughout. 2,297 feet thick.
	Basal conglomerate, 6 feet
Unkar Group. Thickness, 478*a* feet.	Calcareous shales and dolomitic limestones and dolomites containing some ripple marks, sun-cracks; total thickness, 304 feet.
	Ripple-marked, cross-bedded jaspers, quartzitic jasper, intrusive diabase, blue, red, vermilion, argillaceous and arenaceous shales. Thickness 579 feet.
	Pure fine-grained sandstones and quartzites, ripple-marked and cross-bedded. 1,564 feet thick.
Unconformity.	
Vishnu series.	Quartz schist, quartz mica schist, quartz hornblende schist, hornblende schist, quartz diorite and pegmatite granite.

Paige[1] states that the pre-Cambrian complex of Grant County, New Mexico, comprises various types of coarse-to-medium-grained granites and porphyries, and pegmatitic dikes.

Patton[2] finds that the pre-Cambrian rocks of the Grayback Mining district of Costilla Co., Colorado, consist of granite, granite and biotite gneiss, and a small amount of hornblende schist, amphibolite, and pegmatite.

Pardee[3] describes the sedimentary rocks of the Upper St. Joe River in Idaho which are supposed to be equivalent to the Algonkian formations of the Coeur d'Alene district. They consist of sandstones, graywackes, quartzites, shales, garnetiferous mica schists, and limestone.

Ransome[4] states that the basal rocks of the Breckenridge district of Colorado appear as isolated patches of pre-Cambrian schists and gneisses cut by pegmatite and granite.

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[1] Sidney Paige, "Metalliferous Ore Deposits near the Burro Mountains, Grant County, New Mexico," *Bull. 470*, 1911, *U.S. Geological Survey* (1911), pp. 131–50, 1 map.

[2] H. B. Patton et al., "Geology of the Grayback Mining District," *Colo. Geological Survey, Bull., 2*, 1910, 111 pp., 9 pls.

[3] J. T. Pardee, "Geology and Mineralization of the Upper St. Joe River, Idaho," *Bull. 470*, 1910, pp. 39–61, 1 map.

[4] F. L. Ransome, "Geology and Ore Deposits of the Breckenridge District," *U.S.G.S., Prof. Paper 75*, 1911, pp. 187.

Schrader[1] states that the principal topographic features of Mohave County, Arizona, are barren, plainlike, detritus-filled valleys 10 or 12 miles in width, separated by ranges of about equal width. Their trend is a little west of north, and the general slope is toward the southwest.

The ridges consist mainly of pre-Cambrian granites, porphyries, gneisses and schists cut by pre-Tertiary intrusives. The pre-Cambrian probably was once covered or nearly covered by Paleozoic sediments which are now almost completely eroded.

Schrader[2] finds that the pre-Cambrian granites, gneisses, and schists constitute the basement complex on which later sediments of Mohave County, Arizona, have been deposited. No pre-Cambrian sediments have been recognized. The trend of the schists is about N. 30° E. and their dip is either vertical or steeply east-northeast.

Smith[3] believes that the older gneisses of the Sierra Nevada are probably Archaean.

Spurr[4] states that the lowest formation in the Aspen district is pre-Cambrian granite.

Stone[5] finds that in the southeastern part of T. 5 N., R. 2 W., of Montana there is a flat area, underlain by Algonkian sediments of unknown thickness, mostly red shales, including some green shale and thin sandstone beds. They are believed to correspond to the Spokane shale to the east.

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[1] F. C. Schrader, "The Mineral Deposits of Mohave County, Arizona," *Bull. 340, U.S. Geological Survey,* 1907, pp. 53–95.

[2] F. C. Schrader, "Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona," *Bull. 397, U.S. Geological Survey,* 1909, pp. 220.

[3] James Perrin Smith, "The Geological Record of California," *Jour. Geol.,* XVIII, No. 3 (1910), 216–27.

[4] J. Edward Spurr, "Ore Deposition at Aspen, Colorado," *Econ. Geol.,* IV (1909), 301–20.

[5] R. W. Stone, "Geologic Relations of Ore Deposits in the Elkhorn Mountains, Montana," *Bull. 470, U.S. Geological Survey,* 1911, pp. 75–98, 1 map.

Turner[1] describes the complex of pre-Cambrian granite-gneiss, quartz-monzonite gneiss, granite augen schists, calcareous augen schists, and small lenses of hydrous mica-schists of the Silver Peak district of Nevada. Certain dolomites, quartzites, and green knotted schists underlying the Olenellus fauna may be Algonkian, but have been provisionally referred to the Lower Cambrian.

Walcott[2] finds the following succession of pre-Cambrian sediments exposed below basal Cambrian conglomerate in the Bow River valley of Alberta, Canada: Hector formation—shales 1,300–2,150 feet; Corral Creek formation—sandstones 2,600 feet, base not found. He correlates them with the Camp Creek and Sheppard series of arenaceous rocks which lie beneath the Cambrian and above the Siyet limestone in Montana, southwestern Alberta, and southeastern British Columbia.

Weeks[3] finds that the oldest rocks of the Osceola district are granites and schists, with intruded porphyry, which he believes are probably Archaean.

Winchell[4] finds that the lowest rocks exposed in the Ruby range, about 60 miles south of Butte, Mont., are quartz schists and slates, probably of pre-Cambrian age.

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[1] H. W. Turner, "Geology of the Silver Peak Quadrangle," *Bull. of Geol. Soc. Am.*, XX (1909), pp. 223–64, 4 pls., 1 fig.

[2] C. D. Walcott, "Pre-Cambrian Rocks of the Bow River Valley, Alberta, Canada," *Smith. Misc. Coll.*, LIII, No. 7 (August, 1910), pp. 423–31, 3 pls.

[3] F. B. Weeks, "Geology and Mineral Resources of the Osceola Mining District, White Pine County, Nevada," *Bull. 340, U.S. Geological Survey*, 1907, pp. 117–33.

[4] Alexander N. Winchell, "Graphite near Dillon, Montana," *Bull. 470, U.S. Geological Survey*, 1911, pp. 528–32.